CLAIMS:

1. A guided wave optical tunable filter for transmitting a selected frequency channel which is included in a substantially broad range of optical frequencies in an incident light wave, comprising:

(a) a substrate of a birefringent material which exhibits the linear (Pockels) electrooptic effect and the linear strain-optic effect;

(b) an optical waveguide structure which supports a single mode for both TE and TM polarizations formed on said substrate, said optical waveguide structure consisting of a straight initial section, a first symmetric branch, first and second polarization conversion/electrooptic tuning sections, a second symmetric branch, and a straight final section; wherein said initial section is positioned to receive said incident light wave and said final section transmits said selected frequency channel; wherein said first and second polarization conversion/electrooptic tuning sections provide continuous optical paths between said first and second symmetric branches; wherein optical path length experienced by a TE light wave in traversing said straight initial section, said first symmetric branch, said first polarization conversion/electrooptic tuning section, said second symmetric branch, and said straight final section differs from the optical path length experienced by a TE light wave in traversing said straight initial section, said first symmetric branch, said second polarization conversion/electrooptic tuning

section, said second symmetric branch, and said final section by half an optical wavelength;

(c) a multiplicity of strain-inducing strips of a dielectric material situated on top of said polarization conversion/electrooptic tuning waveguide sections; said strain-inducing strips having the effect of inducing polarization coupling in said polarization conversion/electrooptic tuning waveguide sections; said strain-inducing strips having a spatial periodicity Λ such that substantially complete phase-matched polarization conversion occurs in said first and second polarization conversion/electrooptic tuning waveguide sections at said selected optical frequency within said broad range of optical frequencies; said strain-inducing strips situated on top of first polarization conversion/electrooptic tuning waveguide section being offset in position from said strain-inducing strips situated on top of second said polarization conversion/electrooptic tuning waveguide section by an odd integral multiple of $\Lambda/2$, wherein said positions are measured relative to said first symmetric branch;

(d) a source of applied voltage V;

(e) electrodes disposed to produce an electric field in and around said first and second polarization conversion/electrooptic tuning waveguide sections in response to said applied voltage V; wherein said electric field causes a change in the birefringence in said first and second polarization conversion/electrooptic

tuning waveguide sections such that said selected optical frequency is tuned in proportion to said applied voltage; and

(f) means connecting said source of applied voltage to said electrodes.

2. The apparatus of Claim 1 wherein said substrate material is lithium niobate.

3. The apparatus of Claim 1 wherein said substrate material is lithium tantalate.

4. The apparatus of Claim 1 wherein said strain inducing strips comprise a film of fused silica deposited uniformly on said substrate at a substrate temperature > 250°C and subsequently patterned lithographically at or near room temperature.

5. A guided wave optical tunable filter for adding one selected frequency channel to a substantially broad range of optical frequencies in an incident light wave, and for dropping said selected frequency channel from said substantially broad range of optical frequencies in an incident light wave, comprising

(a) a substrate of a birefringent material which exhibits the linear (Pockels) electrooptic effect and the linear strain-optic effect;

(b) an optical waveguide structure which supports a single mode for both TE and TM polarizations formed on said substrate; said optical waveguide structure consisting of a first straight initial throughput section and a second straight initial add section joined in continuous fashion to the two input ports of a first

four port directional coupler, first and second polarization conversion/ electrooptic tuning sections, and a second four port directional coupler of which the two output ports are joined in continuous fashion to a first straight final throughput section and a second straight final drop section; wherein said first initial throughput section is positioned to receive said incident light wave and said first initial add section is positioned to receive input light in said selected frequency channel; wherein said first and second polarization conversion/ electrooptic tuning sections provide continuous optical paths between said first and second four port directional couplers; wherein said first final throughput section transmits said incident light wave plus light in said selected frequency channel coupled into said initial add section minus light in said selected frequency channel coupled out of said final drop section; wherein said second final drop section transmits light in said selected frequency channel coupled out of said final drop section; wherein optical path length experienced by a TE light wave in traversing said straight initial throughput section, said first four port directional coupler, said first polarization conversion/electrooptic tuning section, said second four port directional coupler, and said straight final drop section differs from the optical path length experienced by a TE light wave in traversing said straight initial throughput section, said first four port directional coupler, said second polarization conversion/electrooptic tuning section, said second four port directional coupler, and said straight final drop section by half an optical wavelength;

(c) a multiplicity of strain-inducing strips of a dielectric material situated on top of said polarization conversion/electrooptic tuning waveguide sections; said strain-inducing strips having the effect of inducing polarization coupling in said polarization conversion/electrooptic tuning waveguide sections; said strain-inducing strips having a spatial periodicity Λ such that substantially complete phase-matched polarization conversion occurs in said first and second polarization conversion/electrooptic tuning waveguide sections at said selected optical frequency within said broad range of optical frequencies; said strain-inducing strips situated on top of first polarization conversion/electrooptic tuning waveguide section being offset in position from said strain-inducing strips situated on top of second polarization conversion/electrooptic tuning waveguide section by an odd integral multiple of $\Lambda/2$, wherein said positions are measured relative to said first four-port directional coupler;

(d) a source of applied voltage V;

(e) electrodes disposed to produce an electric field in and around said first and second polarization conversion/electrooptic tuning sections in response to said applied voltage V; wherein said electric field causes a change in the birefringence in said first and second polarization conversion/electrooptic tuning waveguide sections such that said selected optical frequency is tuned in proportion to said applied voltage; and

(f) means connecting said source of applied voltage to said electrodes.

6. The apparatus of Claim 5 wherein said substrate material is lithium niobate.

7. The apparatus of Claim 5 wherein said substrate material is lithium tantalate.

8. The apparatus of Claim 5 wherein said strain inducing strips comprise a film of fused silica deposited uniformly on said substrate at a temperature > 250°C and patterned lithographically at or near room temperature.

9. The apparatus of claim 5 wherein said first four port directional coupler and said second four port directional coupler each satisfy the condition that the sum of the fraction of optical power in TE polarization coupled into a particular input port which exits through a particular output port plus the fraction of optical power in TM polarization coupled into said particular input port which exits through said particular output port is substantially equal to unity.

10. A guided wave optical tunable filter for transmitting a selected frequency channel which is included in a substantially broad range of optical frequencies in an incident light wave, comprising:

(a) a substrate of a birefringent material which exhibits the linear (Pockels) electrooptic effect and the linear strain-optic effect;

(b) an optical waveguide structure which supports a single mode for both TE and TM polarizations formed on said substrate, said optical waveguide structure

consisting of a straight initial section, a first symmetric branch, first and second acoustooptic polarization conversion/tuning sections, a second symmetric branch, and a straight final section; wherein said initial section is positioned to receive said incident light wave and said final section transmits said selected frequency channel; wherein said first and second acoustooptic polarization conversion/tuning sections provide continuous optical paths between said first and second symmetric branches; wherein optical path length experienced by a TE light wave in traversing said straight initial section, said first symmetric branch, said first acoustooptic polarization conversion/tuning section, said second symmetric branch, and said straight final section differs from the optical path length experienced by a TE light wave in traversing said straight initial section, said first symmetric branch, said second acoustooptic polarization conversion/tuning section, said second symmetric branch, and said final section by half an optical wavelength;

(c) a source of applied voltage V(t) varying sinusoidally at a frequency f_a;

(d) interdigital electrodes disposed to generate a surface acoustic wave propagating in said substrate in and around said acoustooptic polarization conversion/tuning waveguide sections in response to said applied voltage V(t); said surface acoustic wave having the effect of inducing polarization coupling in said acoustooptic polarization conversion/tuning waveguide sections; said surface acoustic wave having a wavelength Λ such that substantially complete phase-matched polarization conversion occurs in said first and second acoustooptic

polarization conversion/tuning waveguide sections at said selected optical frequency within said broad range of optical frequencies; wherein phase fronts of said surface acoustic wave in first acoustooptic polarization conversion/tuning waveguide section are offset in position from phase fronts of said surface acoustic wave in second acoustooptic polarization conversion/tuning waveguide section by an odd integral multiple of $\Lambda/2$, wherein said positions are measured relative to said first four-port directional coupler; wherein said selected optical frequency is tuned in proportion to said frequency f_a; and

(e) means connecting said source of applied voltage V(t) to said electrodes.

11. The apparatus of Claim 10 wherein said substrate material is lithium niobate.

12. The apparatus of Claim 10 wherein multiple optical frequencies can be simultaneously selected by applying a voltage waveform V(t) containing multiple acoustic frequencies to said interdigital electrodes; wherein each said acoustic frequency corresponds to a different selected optical frequency.

13. A guided wave optical tunable filter for adding one selected frequency channel to a substantially broad range of optical frequencies in an incident light wave, and for dropping said selected frequency channel from said substantially broad range of optical frequencies in an incident light wave, comprising

(a) a substrate of a birefringent material which exhibits the linear (Pockels) electrooptic effect and the linear strain-optic effect;

(b) an optical waveguide structure which supports a single mode for both TE and TM polarizations formed on said substrate; said optical waveguide structure consisting of a first straight initial throughput section and a second straight initial add section joined in continuous fashion to the two input ports of a first four port directional coupler, first and second acoustooptic polarization conversion/tuning sections, and a second four port directional coupler of which the two output ports are joined in continuous fashion to a first straight final throughput section and a second straight final drop section; wherein said first initial throughput section is positioned to receive said incident light wave and said first initial add section is positioned to receive input light in said selected frequency channel; wherein said first and second acoustooptic polarization conversion/tuning sections provide continuous optical paths between said first and second four port directional couplers; wherein said first final throughput section transmits said incident light wave plus light in said selected frequency channel coupled into said initial add section minus light in said selected frequency channel coupled out of said final drop section; wherein said second final drop section transmits light in said selected frequency channel coupled out of said final drop section; wherein optical path length experienced by a TE light wave in traversing said straight initial throughput section, said first four port directional coupler, said first acoustooptic polarization conversion/tuning

section, said second four port directional coupler, and said straight final drop section differs from the optical path length experienced by a TE light wave in traversing said straight initial throughput section, said first four port directional coupler, said second acoustooptic polarization conversion/tuning section, said second four port directional coupler, and said straight final drop section by half an optical wavelength;

(c) a source of applied voltage V(t) varying sinusoidally at a frequency f_a;

(d) interdigital electrodes disposed to generate a surface acoustic wave propagating in said substrate in and around said acoustooptic polarization conversion/tuning waveguide sections in response to said applied voltage V(t); said surface acoustic wave having the effect of inducing polarization coupling in said acoustooptic polarization conversion/tuning waveguide sections; said surface acoustic wave having a wavelength Λ such that substantially complete phase-matched polarization conversion occurs in said first and second acoustooptic polarization conversion/tuning waveguide sections at said selected optical frequency within said broad range of optical frequencies; wherein phase fronts of said surface acoustic wave in first acoustooptic polarization conversion/tuning waveguide section are offset in position from phase fronts of said surface acoustic wave in second acoustooptic polarization conversion/tuning waveguide section by an odd integral multiple of $\Lambda/2$, wherein said positions are measured

relative to said first four-port directional coupler; wherein said selected optical frequency is tuned in proportion to said frequency f_a; and

(e) means connecting said source of applied voltage V(t) to said electrodes.

14. The apparatus of Claim 13 wherein said substrate material is lithium niobate.

15. The apparatus of Claim 13 wherein multiple optical frequencies can be simultaneously selected by applying a voltage waveform V(t) containing multiple acoustic frequencies to said interdigital electrodes; wherein each said acoustic frequency corresponds to a different selected optical frequency.

16. The apparatus of claim 13 wherein said first four port directional coupler and said second four port directional coupler each satisfy the condition that the sum of the fraction of optical power in TE polarization coupled into a particular input port which exits through a particular output port plus the fraction of optical power in TM polarization coupled into said particular input port which exits through said particular output port is substantially equal to unity.

17. A guided wave tunable filter comprising:

(a) two 3-port Y-branch beam splitters connected to form two spaced apart waveguides between said beam splitters, with an input port and an output port;

(b) the waveguides including an optical path difference of a half-wavelength; and

(c) polarization coupling regions in the two waveguides displaced by half the spacial period of a perturbation responsible for coupling.

18. A guided wave tunable filter comprising:

(a) two 4-port beam splitters connected to form two spaced apart waveguides between said beam splitters, with an upper and a lower input port and an upper and a lower output port;

(b) the waveguides including an optical path difference of a half-wavelength; and

(c) polarization coupling regions in the two waveguides displaced by half the spacial period of a perturbation responsible for coupling.

19. A guided wave tunable filter method comprising the steps of:

(a) connecting two 3-port Y-branch beam splitters so as to form two spaced apart waveguides between said beam splitters, with an input port and an output port;

(b) separating the waveguides by an optical path difference of a half-wavelength;

(c) creating polarization coupling regions in the two waveguides displaced by half the spacial period of a perturbation responsible for coupling; and

(d) introducing propagated light into the guided wave tunable filter.

20. A guided wave tunable filter method comprising the steps of:

(a) connecting two 4-port beam splitters so as to form two spaced apart waveguides between said beam splitters, with upper and lower input ports and upper and lower output ports;

(b) separating the waveguides by an optical path difference of a half-wavelength;

(c) providing polarization coupling regions in the two waveguides displaced by half the spacial period of the perturbation responsible for coupling; and

(d) introducing propagated light into the guided wave tunable filter.